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AMERICAN METEOROLOGICAL JOURNAL.

A Monthly Review of Meteorology, Medical Climatology and Geography.

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THE AMERICAN
METEOROLOGICAL JOURNAL.

VOL. III. ANN ARBOR, SEPTEMBER, 1886. No. 5.

EDITORIAL NOTE.

With this number of THE JOURNAL, Mr. A. Lawrence Rotch becomes associate editor of THE JOURNAL. Mr. Rotch is, as most of our readers know, proprietor of the meteorological observatory on Blue Hill, near Boston; and he will also be recognized as the author of the interesting and important report on mountain observatories which appeared in our columns not long since. We hope that Mr. Rotch's connection with the JOURNAL will give it new life and vigor.

M. W. HARRINGTON.

CURRENT NOTES.

THE ROUMANIAN METEOROLOGICAL INSTITUTE shows much activity under its director, Mr. St. C. Hepites. Its first volume of annals (bearing date of 1886 and imprint of Bucharest) is a quarto of 505 pages. It is in parallel columns of French and Roumanian. It is largely made up of observations for the past year, but also includes an account of the Institute and its work, a history of meteorological work in Roumania and an elaborate account of its instruments and methods of observation. Of interest is the list of publications on Roumanian meteorology, acknowledged incomplete, and yet containing nearly 150 titles; Mr. Hepites has the place of honor in the list, having contributed twenty-six titles. The present volume contains only observations made at Bucharest. Another volume is to appear for those made at other stations.

RAINFALL AND CHOLERA.—Dr. H. B. Baker, of Lansing, read a paper on this subject before the American Public Health Association at its last meeting. From the reprint we take the following conclusions drawn by the author, as the result of his study. The points are so clearly stated, by Dr. Baker, that comment is superfluous:

1. That the mortality from cholera in Calcutta was reduced by about two-thirds, coincidently with the introduction of a good water-supply.

2. That before and since the introduction of good water, the rain fall has apparently controlled the rise and fall of mortality from cholera in Calcutta.

3. That the rain-fall has apparently controlled the mortality from cholera in the suburbs of Calcutta, and in Bombay.

4 That, if two-thirds of the mortality from cholera disappears by a supply of good water, and the original whole and remaining one third are both controlled by the rain-fall, there is a strong inference that the remaining one third of the cholera mortality in Calcutta might be very materially lessened by such a supply of good water as would reach and entirely supply every inhabitant.

5. If the prevention of cholera in its home is so largely dependent upon the rain fall and upon a good water-supply, one direction is thus indicated for most successful efforts for its prevention in this country.

GERMAN METEOROLOGICAL JOURNALS.—The *Zeitschrift* of the Austrian Society, now in its twenty-first year, and that of the German Society, now in its third year, combined forces at the beginning of this year and appear under the title of *Meteorologische Zeitschrift*. The journal is printed at Berlin, and contributions may be sent to the representative of either society. The popular journal *Das Wetter* continues to appear regularly from Magdeburg.

STATE REPORTS, ETC.—Students of meteorology and climate sometimes find it impossible to get access to old state or other reports, and to them we think we are doing a favor by calling attention to a dealer who always carries a large stock. This is Dr. A. A. Foote, of 1223 Belmont Ave., Philadelphia. He publishes a monthly bulletin with lists of his books in various departments of science. That for August of the current year con-

tains the most complete list of state and other reports that we have ever seen.

AN INTERNATIONAL CONGRESS of Hydrology and Climatology meets at Biarritz, in the Pyrenees, on October first. It is under French auspices, but students of all nations are welcomed. There will be in connection with it a climatological exposition open from September 15. On October 9 will begin a series of excursions for the members of the congress, directed more especially to the thermal and sanitary stations of the neighboring mountains. Communications concerning the congress should be directed to the Vicomte de Chasteigner at Biarritz. The fee for members is 12 frances.

THE FUTURE.—C. C. Blake who proposes to predict the weather on principles of "astronomical mathematics," and whose success in prediction we have recently criticized, gives in a recent issue of his paper a prediction for the next winter. The Winter is to be initiated by a blizzard on December 20th, and is to continue, very cold and severe, until April 1st. Our readers may wish to make a memorandum of this and test it for themselves.

THE FLORIDA SHIP-CANAL.—Before the invention and development of railways, the development of waterways received much attention, but with the growth of the former, interest in the latter declined. Railway transportation is, however, relatively expensive and does not lend itself to the carriage of cheap products for long distances. With the development of the railroads the great wheat and corn producing areas have been pushed farther and farther back until they are now west of the Mississippi river; and with the perfection of farm machinery and the low price of western lands, the cost of production of wheat and corn has been reduced until it is probably at a minimum. Thus we have the problem of long carriage of cheap products, where the railways do not serve, and we have again the problem of cheap transportation to solve. Its solution is probably to be found in

renewed development of waterways, and attention is once more being directed strongly to them.

Among the yet undeveloped waterways perhaps the most important is that of the Florida ship-canal. It would obviate the dangers of navigation through the Florida channel and would give direct and practicable water connections between the west and the coasts of the Atlantic. It is proposed that this canal begin at the mouth of the St. Johns' river and end with that of the Suwannee river. The total length of the canal would be 120 miles, and the cut between the rivers (a very easy one) would be but seventy-seven miles long. The canal would save 800 or 900 miles between New Orleans and New York. It would also save a large part of the enormous wreckage on the Florida Keys and the increased insurance demanded from vessels navigating these dangerous waters. The annual loss on the Keys is estimated at eleven millions of dollars.

PERICYCLONES.—Those who have given some attention to the changing atmospheric pressure lines, or isobars, traced on our weather chart from day to day, recognize the value of such lines as indicators of approaching weather conditions without, perhaps, knowing precisely the principles involved in forecasting on the basis of this system of isobars and gradients. These principles are, however, simple enough when once understood, and very little difficulty should be encountered in foreknowing the weather with an isobaric chart at hand.

Having in mind the local wind system and the thermal conditions around the areas of high and low pressure, either wholly or in part shown on the chart, and which, liable to modification, travel with such areas, it is possible to foresee in what sections of the country heavy rains, severe storms, excessive heat, or sudden cold and damaging frosts are liable and likely to occur. The words low and high appearing on the chart have no significance beyond locating the regions where the barometer at the time reads lowest and highest. The former is the center of a cyclonic system and the latter that of an opposite or anti-cyclonic system, the dimensions of both being shown as far as the too limited field of observation permits.

With the characteristics of the indrawing cyclone ("Low") intelligent people are familiar. Anticyclone ("High") is a term proposed by Galton some twenty years ago to express a downflowing and gradually dispersing mass of cold, dry air from the upper regions of the atmosphere. The air flowing away from this mass on all sides gets a lateral motion, and curves to the right. This being directly contrary to the cyclone, the term seems singularly appropriate, and should be generally employed.

The disposition to theorize and word coining is strong among meteorologists. Some of Prof. Ferrel's theories, touching rings or great belts of high pressure, set forth in the July number of the AMERICAN METEOROLOGICAL JOURNAL, by Prof. W. M. Davis, seem to necessitate the adoption of a new term, and Prof. Davis aptly supplies it in the word "pericyclones."—*Cincinnati Commercial Gazette.*

REPORT FOR THE DIVISION OF THE PACIFIC.—Following is a Signal Bulletin for July, 1886, from the Signal Station, United States Army Division of the Pacific, dated San Francisco, California, August 1st:

Temperature.—The average July mean temperature has been maintained everywhere in California, except on the coast line from San Francisco to Los Angeles, where it has been in excess from 1° to 2°. In Oregon and Washington Territory the excess has increased from 1° on the coast to from 3° to 6° in the eastern portion. Unusually high temperatures prevailed in eastern Washington Territory, Idaho, Nevada and over the interior of California from the 8th to 18th, the maximum temperature recorded during that time being as follows: Boise City, 107°; Winnemucca, 100°; Walla Walla, 104°; Spokane Falls, 100°, on the 11th—the two latter stations reached the same point again on the 16th. Sacramento attained 105°, on the 14th; Red Bluff, 100°: Los Angeles, 98°, and San Francisco, 78°, on the 15th. Temperatures of 100°, or over, were reported from Red Bluff and other points in the interior of California from the 10th to 18th, inclusive, and again on the 21st and 31st; on the latter date 100° was recorded at Sacramento.

Rainfall.—The precipitation has been in excess of the average in all portions of the Pacific coast, except along the Sacramento and lower Columbia rivers. In the first no rain has fallen, and in the latter the deficiency is about half an inch. Showers occurred north of the Columbia river on the 1st and 2d, 4th to 9th, the 25th, 26th and 29th; in Oregon on the 3d, 5th, 7th, 19th, and 20th; on the northern California coast on the 8th.

Thunder-storms occurred in Nevada and the mountain region of eastern California from the 12th to the 17th; in northern California on the 16th, 17th and 19th, and in some localities in the southern part of the state on the 14th.

Cloud-bursts were reported in Nevada on the 15th, 17th and 18th; in Arizona on the 17th and 19th, and in the mountain districs of northern California on the 19th.

In the city of San Francisco and its vicinity, on the 16th, .23 of an inch of rain fell accompanied by a thunder-storm—the first occurrence of the kind recorded in July since 1849. *This storm was confined to within fifty miles of the coast, passing from the Salinas to the Sonoma valley, where it disappeared.*

The highest temperature at San Francisco for July was 78°, being within 5° of the highest ever recorded by the Signal Service. The lowest was 50°, which is within 1° of the lowest.

The average July cloudiness at San Francisco is 46 per cent., and the past month has been 35 per cent.

W. A. GLASSFORD,
Lieutenant and Assistant.

HUDSON'S BAY.—The perusal of the full report of Lieut. Gordon to the Dominion Minister of Marine and Fisheries and the inspection of the neat atlas of temperature, which accompanies the report, throws much light on the climate of the straits and northern half of the bay. The exploration was made with reference to its capabilities of navigation, and shows much pluck and energy. The bay has been visited for two seasons and during last winter a force of observers was left at several stations. The results make a decided addition to knowledge.

The first problem of interest to navigators relates to the ice.

The straits may be considered as open during August and September. Frequently passage through them may be made in July, sometimes early in the month. Again for the first two weeks of October the straits often have but little ice, and sometimes they are open for the second fortnight. Lieut. Gordon's steamer, "Alert," was fastened in the ice at the mouth of the straits from June 16th to July 6th, and when free she had to come south for repairs. On her return she found much ice in early August, but the season was acknowledged to be later in 1885 than usual. The bay is open earlier and longer than the straits.

As to weather, low temperatures, fogs, snow storms, and gales are to be expected. The average temperature for the year ran from 10° F., high north, to 25° F., the latter isotherm just skirting the southern end of James' Bay. For February the entire bay and the southern half of the straits averaged below zero, reaching in the northwestern part an average of —20°. August was the warmest month and at this time the isotherm of 40° divided the bay into two nearly equal parts. In the straits the lowest temperature recorded was —34.6°, while on the bay (York Factory) the thermometer fell to —53°. The highest on the bay was 106°; on the straits, 64.6°.

The wind frequently reached a velocity of 50 miles per hour, and at one time a velocity of 84 miles was reached. Snow fell generally in all months except July and August, and at Ashe Inlet, on the north shore of the straits, it fell in August. The number of hours of fog, though large, was not generally so large as at Belle Isle.

European Weather: Review for July.—*Barometric pressure.*—From the 1st till the 4th there is a high pressure central over west and central Europe, but on the 5th minima appear on the coast of Northern Norway and pass over Scandinavia; on the 8th a low pressure descends to Holland, with rain and general thunder-storms, but on the 9th it has traveled to the Baltic, descends on the 10th again to eastern Germany, with rain and thunder-storms, but disappears on the following day in the N.E.; another follows and is situated on the 12th and 13th on the Nor-

wegian coast, descends on the 14th to Scotland and causes there and in its vicinity rain and stormy weather; on the 17th, however, it recedes to the north and high pressure spreads over central Europe, but with relatively low temperature; on the approach of another depression in the west rainfall is again general over Britain, Germany and Holland, it causes stormy winds over Ireland and severe storm on the Scilly islands, with considerable precipitation; the barometer has fallen on the 23d, over Ireland as low as 29.10. This minimum spreads on the 24th as an area of low pressure over the greatest part of Europe, but as the pressure is equally distributed, however, below the normal, calm, cloudy weather prevails; on the 27th there are two minima visible: one on the North Sea and another over northern Italy; on the approach of high pressure from the S. W. both depressions travel in a N. E. direction and disappear on the 30th; high pressure now spreads over central Europe, with calm, clear weather and almost normal temperature, but on the 31st a minimum has traveled to the North Sea, and the high pressure forms two maxima, one over the Gulf of Biscay and another over westerm Russia.

Temperature: Germany.—Below the mean, 1-7, 9-19, 27-31; above the mean, 8, 20-26; lowest, 43° on the 28th, at Kassel; highest on the 19th, 88°, on the 19th at Kaiserslautern and on the 22d at Chemnitz—on the whole a cold month, the temperature below the mean.

Ireland: Valentia.—Below the mean, 8-11, 14-15, 18, 19, 23-28, 30, 31; above the mean, 1-7, 12, 13, 17, 20-22, 29; lowest, 53° on the 8th and 11th; highest, 72° on the 2d.

Sweden: Stockholm.—Below the mean, 1, 2, 4, 7, 9-14, 16-19, 30; above the mean, 3, 5, 6, 8, 15, 20-27, 31; lowest, 55° on the 4th; highest, 77° on the 20th and 22d.

Russia: Petersburg.—Below the mean, 1, 2, 4, 7-13, 30; above the mean, 3, 5, 6, 13-29; lowest, 52° on the 1st; highest, 88° on the 16th.

*Lapland: Hoparanda.*Below the mean, 6-14, 30, 31; above the mean, 1-5, 15-29; lowest, 54° on the 10th; highest, 81° on the 18th.

THE PILOT CHARTS of the North Atlantic Ocean continue to appear with the greatest regularity. They show increasing fullness of information and are now crowded with matter of great interest to meteorologists. The notes on the use of oil at sea still continue, and in the September chart there is a long note on tropical cyclones, and the paths of hurricanes for many years preceding are charted. Capt. Hughes, of the British steamer Nova Scotian reported whales in sight in unusual numbers. From the British Channel to St. Johns, he did not lose sight of them for a single day.

A NEWSPAPER ENTERPRISE:—The excellent Meteorological observatory of the *Magdeburgische Zeitung* still continues its work under Dr. Assmann's directorship, with unabated industry. The Yearbook for 1884 has just been published and shows that the work continues in the same lines as in the two preceding volumes. It is a station of the first order and the amount of good work which it accomplishes is very large.

THE ALTITUDE OF LEADVILLE is 10,178 feet. It is thus higher than any point east of the Rocky Mountains. It is more than twice as high as Mt. Washington, and nearly twice as high as Mt. Mitchell, the culminating point of the Appalachians. It is 2,500 feet higher than the City of Mexico and 3,000 feet above Santa Fe, New Mexico. Its elevation is remarkable and indisputable and it is undoubtedly the highest city in the United States, but there are several cities in other parts of the world that surpass it. In Bolivia, Sucre, the capital, is at an elevation of about 10,500, so near that of Leadville that, as both are very uneven and elevations differ much in different parts, they can be considered as at the same altitude. But La Paz, in the same republic; is at an elevation of 12,000 feet and the mining city of Potosi is about 13,000 feet above the sea.

In Peru there is a station on the railway from Arequipa to Puno which is at an elevation of 14,500 feet. This is higher than Pike's Peak. The place is probably not large enough to deserve the name of city.

There is another region where the altitudes of several cities surpass that of Leadville, and that is the region of Thibet and the Himalayas. Shassa, the capital of Thibet, with a population of perhaps 2,500, is put by the latest authorities at an elevation of 11,900 feet, nearly 2,000 feet higher than Leadville. Monktenath is 13,150, Gya is 13,500, and Kursok at the extraordinary elevation of 14,900 feet above ocean level. The three latter places are recorded as towns, though the writer has not been able to ascertain their size.

We have thus a list of six towns at a greater elevation than Leadville, two surpassing it by a third of Leadville's total elevation. If we take nominal towns, however, several can probably be found in Colorado higher than Leadville.

ALTITUDES IN THE SIERRA DE CORDOBA:—An interesting mountain-group is that of the western part of the state of Cordoba in Argentina. It is nearly central for the republic and is the most notable of the mountain outposts which encroach on the pampas and gran chaco. Its elevations have been the subject of considerable study, the latest of which is a series of aneroid readings by Dr. Oscar Doering, the well known meteorologist of the city of Cordoba, who publishes in the latest volume of the *Boletin de la Academia Nacional* a list of fifty. The highest point is the peak of Champaqui which is made out from seven comparisons, to be 2,880 meters (9,449 feet). Several other points follow not far behind. Cordoba itself, though 246 miles from Rosario on the Parana, is in a sort of depression and has an elevation of only about 1,325 feet above the sea so that the Cordoba Sierra must range about as high above the city as does the Pike's Peak group above Colorado Springs.

METEOROLOGY IN CALIFORNIA:—We have already called attention to Lieut. Glassford's collections and studies of rainfall statistics in California. Very few regions have fuller rainfall statistics than the Pacific coast is now collecting under Lieut. Glassford. We have also frequently called attention to Dr. Trembley's study of Oakland climate. We have before us now

another valuable addition to the literature on the climate of California in Sergeant Barwick's pamphlet on the meteorology and climatology of the great valleys and foothills of California. This is a collection of facts and discussions made by Sergt. Barwick as meteorologist of the State Board of Agriculture and the pamphlet is published by that Board.

The pamphlet contains meteorological data extending in some cases through thirty-six years and much attention is given to a comparison of Californian and other temperatures. It has also a brief sketch on the modifying climatic effects of the western descents on the great valleys of California and on the northerly winds of California. The latter is by J. H. C. Bonté and while it contains much information of interest, yet the author does produce conviction of the correctness of his conclusions.

The California northers are, it appears, hot and dry, in summer, and exercise a deleterious effect on living beings. Their evaporating power is especially remarkable and characteristic and Mr. Bonté has seen them evaporate a full inch of water in twenty-four hours. They are often very injurious to vegetation, drying and hardening fruit on the side exposed to the north, blackening, charring and curling up young and tender leaves, cutting off the fragrance of odorous plants, killing young sprouts in a few hours. In fact they effect plants like a fire and the deleterious effects are produced with remarkable promptitude.

On animals the effects are almost as remarkable. Cows give one-third less milk during the prevalence of the Californian Northers. Horses require double the usual effort to do their work. Young fowls are sickened in a few hours, and, if the wind continues, droop and die. Cattle become nervous, restless and thirsty. Birds become feverish, lose their appetites, and cease to chirp and sing, and they often fall dead from the trees. The nose of the setter dog grows dry and he no longer takes the scent.

On man the effects are also marked. "Healthy and strong individuals feel an inconvenience, an agitation, a heaviness difficult to express; the muscular system is more sluggish; individuals afflicted with rheumatism feel their pains renewed; neu-

ralgias increase in intensity or their paroxysms reappear; men are cross-grained and quarrelsome; fights are of frequent occurrence, and our landladies are seldom found in their usual amiable mood. In general, our patients afflicted with chronic or acute affections, feel an aggravation of their usual symptoms; they are more fatigued, more agitated and their febrile state is increased, while, without being able to give any reason for it, they are often gloomy and despondent. Urinary secretions contain an excess of solid ingredients, and is diminished in quantity. The functions of the brain are disturbed by the same morbific influence, resulting in slight headache and drowsiness, with a marked disinclination for either mental or physical action." The wind is called a "poison wind" and makes the skin and hair rough and dry. Though highly disagreeable to most to some it is enjoyable. Mr. Bonté finds that on the whole its beneficial effects surpass its injurious ones and attributes the fine climate of the central valleys to these north winds.

While the winds are called northers they seem to be properly northwestern. They are felt throughout the great central valley of California. Their unpleasant effects are most marked at the northern and southern ends of the valley. They recur about once a fortnight, but hot blasts come on only about ten times a year and extremely vicious ones only about once in six or eight years. They continue from one to thirteen days, averaging about three days. The wind generally ceases at night though it sometimes continues all night long. They are not generally high winds and the lay of the valley is such that this is about the only wind they have. So little wind occurs from other points that the windmills are generally set to take advantage of these winds and are incapable of turning for others.

As to the explanation of the peculiarities of these winds, it is hardly worth while to search for mysterious causes or those unknown elsewhere. While our information is not yet complete, it seems complete enough to give the explanation in general terms. It is that the general winds which reach the valley must pass over high mountains before attaining it. The passage over the mountains robs the air of most of its moisture and the des-

cent from the mountain tops adds to its heat. The wind is thus fœhn-like in character and is a phenomenon very similar to the Chinooks so common to the east and northeast, the other side of the great divide of the continent.

The problems with the study of which the Californian meteorologists are occupied are of unusual interest, and their solution will well repay the labor put on them. Among them is one to which Prof. T. C. George called our attention some time ago and that is the actuality and character of the seeming change taking place in Californian climate. This is especially seen in the rainfall which has certainly been greater for the last few years.

EXPOSITION OF THE IOWA WEATHER-SERVICE.—The exposition of a state weather-service is a new idea in this country and, used for the purpose of creating greater public interest in the work, the idea is an excellent one. Such an exposition Dr. Hinricks is to make at the Iowa state fair for 1886. In this first exposition of the service a selection from the directors' material only will be displayed. In future years instruments and methods will be shown.

RAILWAY METEOROLOGICAL OBSERVATION.—It does not seem to be generally known by meteorologists that the railways usually take regular observations. The Californians are making use of those taken by the Central Pacific and the Denver and Rio Grande Railroad places its observations at the service of the Colorado Meteorological society. Besides these we do not know that the railway observations are systematically used by meteorologists in this country.

While the observations are taken by the railway corporations for their own use and are in no sense public property, yet we have no doubt they would be at the service of any one who could properly use them. They are usually taken by men who are very busy with other duties and who are not experienced observers yet in some cases they would form a very valuable series to draw from, and doubtless a few judicious recommendations to railway managers would improve their character.

There is also a series of electric phenomena which is regularly noted and reported on by the railways. These are the disturbances of telegraph lines which interfere with the transmission of messages. They probably coincide with what are now called magnetic storms and the publication of a list, with notes, taken from railway records would doubtless serve a useful purpose.

As the railways frequently consult meteorologists when questions come up relating to losses depending on the weather, the accommodation could doubtless be made reciprocal.

SHOULD OBSERVERS BE METEOROLOGISTS?—If the above question were put in this form:—Which is the better observer in any science, one who knows the science or one who does not?—there could be no doubt as to the answer. An astronomical observer who does not know any astronomy or a botanical observer who does not know botany would be anomalies, not entirely unknown to be sure, but confessedly undesirable. An observer who has some information and thinks, observes more intelligently and consequently more accurately and conscientiously, than one who is not informed and does no thinking on his own account. And yet it is, in some quarters, held that a meteorological observer has no right to think for himself and to keep him from thinking he is discouraged from continuing his meteorological studies. This, we believe, is all wrong. The efficiency of our meteorological services would be much increased by making the observers thoroughly well informed and thoroughly interested in what they are doing. The rudest men may make the best soldiers (though we doubt that) but certainly the most intelligent men make the best observers.

A REMARKABLE YEAR:—We usually think the last year more remarkable than its predecessors, partly because its impressions are fresh and partly with the development of the news-gathering powers of the newspapers we have fuller information concerning it. But on any scale the year 1886 will probably be considered a remarkable one for this country.

In this year we have had a very unusual drouth everywheres

east of the Rocky Mountains. The drouth was remarkable for its duration (several months) and for its extent. It was generally severe and in some places it was so severe that, had it not been for the network of railways, local famines with considerable loss of life must have occurred. It was perhaps most severe in southwestern Texas and eastern New Mexico where in some places twelve months passed without rain and the traveller would often see as many dead cattle as young calves. Early in September the drouth was generally broken by abundant and heavy rains.

The year is also notable for the relatively small number of local storms. As a result of the great dryness,thunderstorms and tornadoes have been relatively infrequent. Though the tornado season opened with some destructive ones, the summer months have been almost free from them. Precipitation from general storms almost ceased. Nearly all the rain has been local in character and infrequent.

The year will also be remembered for the very remarkable earthquakes beginning August 28th, contemporaneous with those in Greece, culminating in those of the night of the 31st and the following day,and continuing nearly to the present (September 11th). We may not be done with them yet. On August 28th a slight shock occurred at 4:48 A. M. in North and South Carolina and Georgia. The next one was on August 31st at about 9 o'clock Central Standard time. It was felt generally east of the Mississippi river. It was most severe along the south Atlantic seaboard and especially destructive at Charleston where alone it caused considerable loss of life. At Ann Arbor it was so light that it was felt only on Observatory Hill where it set the dome to turning on its balls and gave an appreciable rock to beds. From this time the shocks came at irregular and gradually increasing intervals for a week or more, all the latter being felt only in the southeastern states.

This earthquake is the most remarkable ever recorded in the United States. That at Santa Barbara, before American occupation, killed more people and that of the lower Mississippi valley in 1811 (the New Madrid earthquake) lasted several months

and so probably had a greater duration than this. This, however covered a remarkable extent of territory, perhaps one-third of the United States. As it occurred in a region easily accessible to and, to some extent, already occupied by competent observers, it is to be hoped that it may also be remarkable in the study given to it. This appears probable in that it has apparently attracted the attention of the national geological survey.

LOOMIS' "CONTRIBUTIONS TO METEOROLOGY."—THE ORIGIN AND DEVELOPMENT OF STORMS.

INTRODUCTORY.

In a series of papers which have been published by Prof. Loomis in the *American Journal of Science and Arts*, under the heading "Contribution to Meteorology," we have one of the best pieces of work in inductive meteorology of the present age. Many readers have not access to these in their complete form, and it was thought that a summary of the chief results would be of interest to the student of meteorology.

The method which I have adopted in preparing the summary is to select from the various papers the results bearing on each subject, and then to connect them in a consistent whole. The manner of presenting them is hence my own, and Loomis can not be held entirely responsible for all of the ideas suggested; though the endeavor will be to give his views as nearly as possible.

In this manner it is hoped to give a complete summary of his work, dwelling, most fully on those subjects which seem of most importance, and a few thoughts by the present writer will be appended to each article.

DEFINITION OF STORMS.

The word *storm* in these papers is used to describe those larger circulations of the atmosphere, whether gentle or violent, which are distinguished by a central "area of relatively low pressure," by an inward inclination of the wind, and usually by cloudiness and rain. Loomis shows in his first paper that in the United States the average inward inclination of the wind is

at an angle of about 45° with the tangent. On the great oceans the inward inclination has been found to be less. Loomis shows in his seventh paper that precipitation is a usual but not an invariable accompaniment of storms.

PLACES OF ORIGIN.

Storms have been known to originate in almost every part of the northern hemisphere, but much more frequently at certain places than at others. "The tropical cyclones, which pursue a westerly course, are limited to two districts. 1st, The Atlantic Ocean, and chiefly its western part near the West Indies; and 2d, the regions south of the continent of Asia.

"Tropical cyclones have never been observed in any part of the Pacific Ocean, with the exception of its western portion near the continent of Asia and the neighboring islands."—Loomis 21st paper.

"The lowest latitude in which a cyclone has been found near the West Indies is 10°, and the lowest latitude in the neighborhood of Southern Asia is 6°. Violent squalls and fresh gales of wind have, however, been encountered directly under the equator."—Loomis 14th paper.

The northern part of the Atlantic and Pacific Oceans, and the Eastern Slope of the Rocky Mts. (Loomis 1st paper) are the places where storms have been most frequently observed to originate in the temperate zones.

TIME OF ORIGIN.

Prof. Loomis found from a large number of cases examined that thet ropical storms near the south of Asia occurred almost entirely in the Spring and Autumn. "Fifty-two per cent. occurred in the months of September, October and November, and forty-three per cent. occurred in the months of April, May and June, leaving only five per cent. of the cases for the remaining six months of the year." "American hurricanes are mostly confined to the period near the Autumnal equinox." "Eighty-eight per cent. occurred in the months of August, September and October, leaving only twelve per cent. for the remaining months of the year."—Loomis 14th paper.

In the temperate zones, storms originate with almost equal frequency at all times of the year.

CAUSE OF ORIGIN.

Storms undoubtedly "result from a general movement of the atmosphere toward a central area."—Loomis 7th paper. As a necessary consequence, there must exist "an upward movement of the air" in the storm area.—Loomis 1st paper.

What then gives rise to this inward and upward movement of the air?

It has been believed as a result of dynamic laws that a rapid vertical decrease of temperature will give rise to ascending and descending currents of air. "If the air at Pike's Peak should be 40° colder than at Denver, it would tend to sink, and the air at Denver to rise."—Loomis 13th paper. (In other words, there would be just such conditions as exist in storms, the air at the earth's surface would blow out from the place where the air was descending toward the place where it was ascending.) These stations are near together, and are in the region of most frequent storm development in the United States. In order to study the conditions attending the most striking contrasts of temperature between these two station, Prof. Loomis "selected from the volumes of the published observations of the Signal Service, (Nov. 1873 to Jan. 1875, and from Jan. 1877 to May 1877) all of the cases in which the temperature at Pike's Peak was 40° lower than at Denver." "The number of these cases in twenty months of observation was 343. Only 39 of these cases occurred during the seven winter months of observation, and they occurred most frequently in the month of May. * * * * The facts appear to show that at the dates given there was seldom any extraordinary disturbances on Pikes Peak. In two cases hail was reported, in four cases sleet, and in fifteen cases either rain or snow. These facts seem to indicate an occasional uprising; but it is remarkable that so few such cases occur; and it will be noticed that a difference of temperature of at least 45° between Pike's Peak and Denver often continued from day to day for long periods. * * * I think we may hence infer that

dry air even when greatly heated has but little ascensional force * * *."—Loomis 13th paper.

These facts which are in accordance with what has been found in large deserts in various parts of the world seem to prove that the direct heating of the air near the earth's surface by the sun's rays is not the essential, and certainly not the only cause of the origin of storms.*

It has, however, been supposed that while the direct heating of the air may not give rise to currents sufficiently strong to produce storms, if the condensation of vapor takes place the conditions arise which produce storms.

Taking the published observations of the Signal Service for eleven months (Sept. 1872 to July 1873) Loomis divided the storms observed into three classes. 1st, "Those in which the barometric depression in the center of the storm was the same on two successive dates, or the change was less than .005 inch; 2d, "Those in which the pressure at the center *decreased* to the extent of at least .005 inch; and 3d, "Those in which the pressure at the center *increased* to the extent of at least .005 inch." "The following is the result of this comparison including 194 cases for eleven months of observations."

	No. of cases.	Average Barometer at Center.	Variation in 24 hours.	AMOUNT OF RAINFALL. Within Isobar. 29.90	Within Isobar. 29.80	Greatest fall at any station.
Pressure increasing...	45	29.58	+.100	.069 in.	.078 in.	0.65 in.
Pressure stationary...	81	29.56	—.005	.120 in.	.149 in.	0.86 in.
Pressure decreasing...	68	29.48	—.128	.134 in.	.159 in.	1.02 in.

*Storms sometimes originate along the eastern Rocky Mountain slope when the temperature of the air is lower there than in any part of the United States. (For an example see the Signal Service Charts of January 19-20, 1886), and storms appear to originate in this region as often in the night as in the day.

"These results clearly indicate that the amount of rainfall is least when the pressure at the center of the storm is increasing, or the storm is diminishing in intensity; and the amount of rainfall is greatest when the pressure at the center of the storm is decreasing, or the storm is increasing in intensity, and we arrive at the same conclusions whether we take the average rainfall at all of the stations within the isobar 29.90; or confine ourselves to the stations within the isobar 29.80; or take simply the single station which reports the greatest rainfall. This effect is most decided during the colder months of the year."—Loomis 5th paper.

On the other hand Loomis found that heavy rainfall was not necessarily productive of storms. In his 6th, 7th and 17th papers he examined all of those cases during several periods aggregating four years of observations where the published observations of the Signal Service showed an unusually large rainfall in any part of the United States. In his sixth paper after examining a large number of cases he says: "We conclude therefore that great rainfalls do not generally continue over eight hours and very rarely do they continue for twenty-four hours, either as experienced at one station, or in succession at different places." He arrives at the same conclusion in his 7th and 17th paper; and adds, "the forces which impart that movement to the air which is requisite to an abundant precipitation of vapor, instead of deriving increased force from a great fall of rain, rapidly expend themselves and become exhausted." Storms may also exist without rainfall. Loomis selected from the published volumes of the United States Signal Service, and tabulated "all of those cases during a period of 15 months (Sept. 1872 to Nov. 1875) in which the rainfall did not amount to one-tenth of an inch in eight hours at any of the stations." "This table shows that barometric minima frequently occur with very little rain. Of the 101 cases here mentioned more than half showed a pressure less than 29.70; more than one-third were below 29.60 and nearly one quarter of the cases were below 29.50." These cases occurred most frequently in autumn and least frequently in summer. As a result of the examination

Loomis says, "there seems to be no room for doubt that barometric minima sometimes form with little or no rain, and continue without any considerable rain for eight hours, and sometimes for twenty-four hours, or longer." In this paper is given a chart of a storm which occurred in the Missouri Valley on Oct. 19–21, 1872, during which time the lowest isobar varied from 29.80 to 29.60. "During these forty-eight hours not a drop of rain was recorded at any station within the area of a pressure less than thirty inches, although on the 20th of October this area had a diameter of 1,500 miles," * * * * "so that it seems safe to conclude that *rainfall is not essential to the formation of areas of low barometer, and is not the principal cause of their formation or of their progressive motion.*"—Loomis 7th paper.

"In order to determine the circumstances under which storms originate, and ultimately acquire their full intensity," Prof. Loomis "selected from the published volumes of the Signal Service observations (Sept. 1872 to May, 1874), all of those cases in which the barometer fell below 29.25 inches at any station." Among these he found thirty-six cases in which the accompanying storm appeared to have developed in the United States, and he says: "The first stage in the development of each of these storms was an area several hundred miles in diameter, over which the height of the barometer differed but little from thirty inches, with an area of high barometer both on the east and west sides, and at a distance of about 1,000 miles. In the few cases in which a high barometer is not reported on both sides of the origin, it is because the area of the observations was not sufficiently extended. The mean value of the high barometer on the east side was 30.42 inches, and the mean distance 1,033 miles; on the west side the values were 30.31 inches and 977 miles. * * * On Hoffmeyer's storm charts we frequently find three areas of high barometer, and occasionally four areas of high barometer surrounding an area of low barometer. These areas of high barometer are regarded as one of the causes, and generally the most important cause of the storm which succeeds. * * * Since the air presses in on all sides towards this area of low barome-

ter, the area tends to assume an oval form, which may become sensibly circular if the winds are very violent, and the centrifugal force resulting from this revolving motion causes a still further depression of the barometer. * * * Rain is one of the circumstances which increases the force of a storm, and it invariably attends storms when they have attained to considerable violence * * * some rain was invariably reported whenever the barometer fell below 29.4 inches, and generally there was some rain reported whenever the barometer fell below 29.5 inches. I have found no storm of great violence which was not accompanied by a considerable fall of rain."—Loomis 8th paper.

Distant areas of high pressure thus seem to be the immediate cause of the origin of storms in the United States; but it may be that the increase in the violence of distant storms due to condensation of aqueous vapor is the ultimate cause.

In his 17th paper from an examination of the International Weather maps Loomis says: "We find from these maps that the entire northern hemisphere, north of lat. 30°, is generally covered by successive areas of high and low pressure which are advancing eastward with unequal velocities, and are daily undergoing important modifications. If one storm increases or diminishes in intensity, this change must affect the adjoining areas of high pressure, and this in turn must affect the areas of low pressure which prevail beyond these areas of high pressure."

REMARKS BY THE PRESENT WRITER.

Prof. J. Eliot as a result of the study of storms in the Bay of Bengal says: "The entire development of all storms in the Bay of Bengal appears to be due to actions occurring over the Bay itself, and not to atmospheric conditions at a considerable distance from the arch of cyclonic disturbance," and he has given strong reasons for believing that the immediate cause of the storm is the condensation of aqueous vapor at the place of the storm origin.—See this JOURNAL, Vol. II, p. 221.

This view, however, and that of Prof. Loomis fall readily under one law, viz.: *Storms originate and are maintained by*

such differences of pressure as tend to make the air move inward toward a central area of minimum pressure.

Such differences of pressure may be produced in various ways.

1st. By differences of temperature produced by the direct rays of the sun acting differently on different parts of the earth's surface. It has been shown by experiments familiar to all that if one body of air becomes warmer than the adjacent air it expands and overflows and a difference of pressure results.

2d. By differences of humidity. Dryer air is heavier than damper air, and when bodies of air differing in humidity are near together differences in pressure must tend to arise.

3d. By differences of electrical potential. It seems probable that columns of air at higher electrical potentials are more powerfully attracted toward the earth's surface than surrounding air, and differences of pressure result.

4th. By condensation of aqueous vapor. This retards the cooling of ascending air, thus causing differences of temperature between larger bodies of air, and consequently more marked differences of pressure.

5th. By centrifugal force arising from the earth's rotations. When air begins to move inward toward a central area it is deflected from a straight line on account of the earth's rotation and moves spirally inward, circulating around the center. A centrifugal force is thus developed which reduces the pressure at the center of the area and increases it on all sides.

6th. By differences of pressure previously existing at a distance from one another so changing their relative positions that a central area of minimum pressure and an inward movement of the air is originated between them. This as Prof. Loomis has shown is probably the way most storms are originated since the earth is continuously covered with areas of high and low pressure ever changing their positions relatively to one another, and varying in intensity as a result of precipitation of vapor or other causes.

Loomis has shown as stated in this paper that the first three or four methods mentioned above are not sufficient to produce storms, but it is possible that in such cases as those pointed out

by Eliot they give that primary impulse which is necessary to allow the other forces opportunity to act.

The law italicized above is, however, independent of the truth of any of the methods given. It represents an observed fact, and has been consciously or unconsciously assumed by every writer in meteorology whether he has believed that heat only, electricity only, or these combined with the rotation of the earth, etc., were the causes of all weather changes; and their theories were largely directed toward explaining this law.

The law no doubt applies to thunder-storms as well as general storms; only thunder-storms originate above the earth's surface as cumulus clouds, and the forces producing the action are somewhat modified.

H. HELM CLAYTON.

BLUE HILL OBSERVATORY, July 15, 1886.

[TO BE CONTINUED.]

THE RECENT EARTHQUAKE IN GREECE AND OTHER PLACES ON AUGUST 28, 1886.

In my paper to the Philadelphia meeting of the A. A. A. S., which you published in your December, 1884, number of the METEOROLOGICAL JOURNAL, I mentioned the tendency of seismic movements to follow belts of great circles; especially one or other of the five equidistant great circles, which mark successively eastern continental trends at 72° apart, measured on the equator, and thence having a trend N. 23½° E; first the eastern coast of Asia, next that of Africa, thence successively, going west, of South America, North America and of Oceanica. These five continental trends, for the sake of brevity, I designated in one communication to the A. A. A. S. as A, B, C, D, and E, while their mates, namely those great circles intersecting these five trends at the equator and running N. 23½° W., were called A′, B′, C′, D′, and E′.

The recent earthquake, chiefly destructive in the Morea and Zante, but also felt considerably in Egypt and in South Carolina, confirms not only the above generalization or law, but also two others, to which allusion had been made in previous

papers, namely that these belts generally pass from one important volcanic region to another, and that seismic movements propagated along one great circle, may when intersected by another important great circle, transfer a part of their force, or even the whole to this secondary side track.

This great circle B′, uniting the volcanoes of Bourbon (or Reunion) with those of Iceland, passes through Egypt parallel to the Red Sea, reaches Santorin, traverses the Morea, causing the frequent earth tremors at Janina in the Epirus, reaches Iceland, thence passes to our National Park, with its ten thousand geysers, and passes out of the United States near Santa Barbara. Therefore it would not have been surprising, but rather in accordance with expectation, if California had felt some shocks on the 28th. But the force seems to have been shunted in Iceland to great circle D, which defines the E. trend of our North American coast, passing through South Carolina on its way to the perpetual volcanoes of Massaya and Izalco,[1] in San Salvador, besides all the others of terrific activity in that region.

A short time since, I received through Dr. Foote, a number of pamphlets by the late Alex. Perrey, giving earthquake records later than those published by Mallet. On carefully tracing those of nearly similar date, I find they very generally come under the law above enunciated. But I could not complete my examinations (which I hope to resume soon, if health permits), because I was busy with a paper and illustrations which I sent to the Buffalo meeting of A. A. A. S. Subject: "The Connection between Meteorology and Terrestrial Magnetism."

CORRELATION OF THE EARTHQUAKES IN UNITED STATES AUGUST 31, 1886, WITH THOSE OF EUROPE ON 28TH OF SAME MONTH.

Since I sent the communication showing the possibility of the earthquake of August 28, which affected Egypt and still more Greece, being propagated along a great circle which I called B′, later intelligence brings the information that the geysers in the Yellowstone Park, which I remarked were on that great circle,

[1] See Humboldt's Cosmos, Vol. IV, p. 251.

had been in unusual activity and that California, also on that belt had been somewhat shaken. Great circle D, which I remarked intersected the other in Iceland, and probably conveyed a portion of the seismic force to South Carolina, we now find must have received a large share as the effect, chiefly in Charleston is greater than ever experienced before in North America. The newspapers say it was felt from New York to Florida, and the lateral tremors emanating from this trend S. $23\frac{1}{2}°$ W. would naturally be mostly from about E. to W.; such was the case in this town, and elsewhere in Indiana, as estimated by the swinging of lamps, etc.

The five continental great circles A, B, C, D, and E, are no accidental selections; they pass from Arctic to Antarctic circles, and define the eastern equidistant continental outlines, successively, of Asia, Africa, South America, North America, and sunken Oceanica; and they can be traced readily, on any good globe, by elevating the N. pole $23\frac{1}{2}°$ above the horizon and revolving the globe from W. to E. These continental trends are secondaries to the ecliptic. To trace A′, B′, C′, D′, and E′ depress the N. pole of the globe $23\frac{1}{2}°$ below the horizon and revolve as before.

The entire study of these recent earthquakes fully corroborates all that has been stated in my paper to the A. A. A. S., as well as the correctness of the laws or generalizations enunciated above.

In the article on British Earthquakes, which was published December, 1884, I showed the connection between Etna, Stromboli and Vesuvius, through Switzerland (the poles of the land hemisphere) the E. coast of England, and Iceland. Here again, as Vesuvius is reported active, we have probably a portion of the seismic energy, which was propagated from Greece to Iceland along B′, now "shunted" from Iceland to the great circle which passes, from that great focus of volcanic activity, through Vesuvius and Etna.

RICHARD OWEN.

NEW HARMONY, Indiana, Aug. 31, 1886.

RESULTS OF SOLAR RADIATION OBSERVATIONS IN THE NEIGHBORHOOD OF BIRMINGHAM, 1875–1884.

BY RUPERT T. SMITH, F. R. Met. Soc. M. Inst. C. I.

Quar. Jour. Royal Met. Soc. for July, 1886.

This paper contains the results deduced from observations made at four different stations within ten miles of Birmingham at heights varying from 501 to 805 feet above sea-level. The solar radiation thermometer (black bulb *in vacuo*) was verified before insertion in its jacket, and was the same throughout. The period of observation was from July, 1875, to December, 1884, nine and one-half years. Vapor tension and cloud observations were also made. The first part of the following table contains the mean monthly averages of the whole period.

Month.	Solar Radiation	Vapor Tension.	Cloud.	θ'	$\theta - \theta'$	I
	°	In.		°	°	Calories
January	13.3	0.185	7.0	6.6	7.4	0.287
February	27.1	.223	7.5	7.5	15.1	0.600
March	39.8	.203	6.1	8.4	22.1	0.906
April	42.9	.238	6.6	11.2	23.8	1.002
May	43.9	.254	6.0	14.2	24.4	1.050
June	42.9	.326	6.1	17.3	23.8	1.051
July	41.3	.388	6.7	18.4	22.9	1.016
August	39.9	.398	6.9	18.9	22.2	0.986
September	38.1	.352	6.1	16.4	21.2	0.917
October	28.9	.285	6.4	12.2	16.1	0.662
November	19.3	.226	6.2	8.5	10.7	0.420
December	13.1	0.194	6.5	6.4	7.3	0.275

In this table the differences of temperature between the maximum of the black bulb thermometer and that of the air temperature has been taken as the true relative measure of the intensity of solar radiation. If this were true, and the atmosphere were homogeneous with regard to vapor tension, cloud, etc., throughout the whole year, the intensity of radiation would be symmetrical on the two sides of June 20th, where the maximum would occur, and hence it would be a very little less for May, April, March, etc., than for July, August, September, etc., respectively. This, it is seen, is not the case, and, as the author

remarks, "the march of mean solar radiation is a peculiar one, the ascending portion being one-third of the year exactly, and the descending portion being two-thirds of the year exactly." The author finds no satisfactory explanation of this in the varying amount of vapor tension and cloud during the year, and concludes "that there is no directly traceable connection between aqueous vapor tension and solar radiation." There is a little less amount of cloud in May than in any other month, which explains somewhat the maximum of intensity of radiation in that month, but the degrees of cloudiness for the other months do not explain fully the differences in solar radiation between May and July, April and August, March and September, etc. For instance, the amount of cloud is nearly the same for April and August, and exactly equal for March and September, but yet the intensities of solar radiation for the spring months are considerably greater than those of the corresponding summer and fall months in which they should be very nearly the same.

In Vol. II, p. 303 of this journal, it has been shown that the differences between the temperatures of the black bulb and those of the air, even when taken simultaneously, are not true relative measures of the intensities of the sun's radiation, but that they depend also upon the air temperature, so that the same differences indicate greater intensities in warm than in cold weather, and consequently in summer than in winter, and in the afternoon of the day than in the morning. The formula which gives approximately the absolute intensities of solar radiation, in calories per minute, has been given in "The Temperature of the Atmosphere and the Earth's Surface," professional paper of the signal service, No. XIII. It is

$$I = 4.584\ \mu^{\theta'}\ (\mu^{\theta-\theta'}-1)$$

in which

I = the intensity of solar radiation in calories per minute,
θ = the temperature of the black bulb thermometer in centigrade degrees,
θ' = that of the air, or rather, of the glass inclosure,
$\mu = 1.0077$.

The numerical constant 4.585 is only provisional and approxi.

mate, but it seems to give about the same intensities as are obtained by other reliable means, and so is, perhaps, not much in error. This, however, is a matter of no consequence here, as we need only a true *relative* measure.

It is seen from a mere inspection of the formula that $(\theta - \theta')$ and I are not proportional in their variations, and that, consequently, the former is not a true relative measure of the latter, and that, with the same value of I that of $(\theta - \theta')$ must decrease as θ' increases, and consequently must be greater in general during the spring when θ' is less, then in the summer and fall when θ' is greater. This explains the rapid increase of solar radiation from winter to summer, and the occurrence of the maximum in May, when we use $(\theta - \theta')$ as the measure of the intensity of the radiation.

The author has not given the monthly averages of the maximum air temperatures, and therefore, I have taken those at Liverpool for the same period, as being sufficiently exact, since the range of monthly averages of temperature during the year differs, perhaps, but little from that of Birmingham. These are given in centigrade degrees in the preceding table in the column headed θ'. The column headed $(\theta - \theta')$ gives the observed differences of the maximum temperatures of the black bulb and the air, also in centigrade degrees. With the values of θ' and $(\theta - \theta')$ in the table, the values of I for each month have been computed by the preceding formula, and given in the last column.

It is seen that these measures of the intensity are more nearly symmetrical on the two sides of June the 20th, and that the ascending portion is now from January to June, and the descending portion from June to January, and that the maximum is in the first part of June, but still a little too early. Comparing, also, May with July, April with August, etc., it is seen that the intensities of radiation of the spring months are still a little too great for those of the corresponding summer months, but this is now readily accounted for by the less amount of vapor tension in the former than the latter, as is seen in the preceding table.

From a discussion of the observations with relation to the different directions of the wind, the author finds that "the solar radiation of all polar winds is about 2.5° higher than that of the equatorial winds." Now the explanation of this is found, at least in part, in the preceding formula, since the temperature of the polar winds must be less than that of the equatorial ones, and by the formula, when θ' is less, $(\theta - \theta')$ must be greater, with the same intensity I. If we suppose the temperature of the polar winds to be 14° F. less than that of the equatorial winds, the formula accounts for the whole difference, and it then becomes simply the effect of using an erroneous measure of the intensity of radiation. But a part of the difference may be, and no doubt is, due to the polar winds being clearer and having less moisture in them. But how much is due to this cause can only be determined by comparing the *true* measures of radiation, in the case of the polar and equatorial winds, and taking the difference.

The preceding formula requires that the two temperatures should be observed simultaneously, and therefore the differences between the maxima cannot be used, since the maximum of the air temperature generally occurs from one to two hours later than that of the black bulb, and this, an hour or more generally after midday, when the radiation is generally the strongest. Using these differences merely as a measure, the author has shown that the difference of the two maxima is less than the differences of the three hourly readings about noon, by one or two degrees.

WM. FERREL.

WASHINGTON, Sept. 4, 1886.

SELECTED ARTICLES.

THE TORNADO AT ST. CLOUD.

Minnesota has had more gratuitous advertising lately than was desirable; and the evil has been increased by the habit of styling tornadoes by the larger name of cyclones. There are points of resemblance, such as the fact that both move vertically around an advancing center, the motion being from right to left, or in a direction opposite to that of the hands of a watch, and both are violent agents of destruction and objects of dread. But there is also a marked difference between the phenomena. The true cyclone starts with a diameter of from 50 to 300 miles, spreading as it advances to one of from 500 to 3,000 miles. Its usual birthplace is amid the tropics, and its fury is exhausted before it reaches this more northern realm. Moving over a large body of water, it piles up mighty tidal waves that finally inundate the land. The tornado, on the other hand, is purely a local affair, originating in some collision of opposing storm currents, assuming a funnel-shaped form, its tail now touching and then rebounding from the earth, and again sweeping along over it like a huge wet blanket, but its greatest diameter rarely exceeding 500 yards. Thus it proceeds in a serpentine way for from a few rods to 25 or 30 miles, when it bursts in some sort of local storm of rain or hail. Should it strike the water, it then becomes a water-spout, as was demonstrated in the case of a tornado in 1883, that swept out of Wisconsin upon Lake Michigan, causing a great commotion there and lifting a column of water some 300 feet high.

Several notable tornadoes have ravaged the Northwest during the last ten years, among which may be mentioned those at Hazel Green, Wis., in June, 1877; at Mankato, Minn., in June, 1880; at Faribault, Minn., in June, 1881; at New Ulm, Minn., at Grinnell, Iowa, at Racine, Wis., in 1883; at Rochester, Minn., in the same year; and at several other localities. But it should be remembered that there have likewise been many storms and tornadoes in other parts of the United States, as appears from

the researches made by Lieut. Finley, whose unique book, bearing the title of "Six Hundred Tornadoes," will give the needed information, together with the supplementary observations made by the same authority.

The universal opinion, however, seems to be that none of the long list exceeds in its destructive energy or terrible manifestations the tornado of St. Cloud and Sauk Rapids, Minn., that took place on April 14, 1886, and of which the writer had the opportunity to make special observations, at least so far as the effects were concerned. Being on the outskirts of the storm, I only saw the massing of black clouds, followed by a spiteful hail, many of the stones measuring more than an inch in diameter; but on a subsequent day I visited the locality, making inquiries of eye-witnesses, and following the tornado's track myself for several miles, and noting its varied effects.

During the day a remarkably high temperature had prevailed for the season, the mercury rising as high as 80°, and the air was sultry and oppressive. At 3 P. M. observers saw dark banks of struggling clouds overhanging the ridge that in ancient times used to be the river limit, and there were apprehensions of impending danger. Suddenly the clouds began to revolve, while sharp points shot downward, until a whirling funnel-shaped mass was formed above a basin amid the hills, that seems to have furnished the cradle for the ensuing tornado. Its first condition was undoubtedly that of a simple whirlwind, having a diameter of about 1,000 feet, which uprooted or twisted off nearly every tree in its circle, overturned the monuments in the adjoining Masonic cemetery, and tore up the bowlders from the ground. Thence it moved slowly and majestically along, at the rate of about 12 or 15 miles an hour, but with an inconceivably rapid rotary motion upon its vertical axis, confining itself for some distance to a path hardly more than 150 feet wide. The pyrotechnic display of flaming colors against a back-ground of sooty blackness was very impressive and wonderful. Hundreds of people took timely warning and got out of the road of the moving column of cloud, whose general trend was toward the northeast. Having wrecked the Catholic church on Calvary Hill, and

also several farmhouses, it entered a portion of the city of St. Cloud mainly occupied by foreigners, whose frame cottages were strewn over the plain indiscriminately, leaving nothing but the cellars to mark the site of the houses.

I noticed but one exception to this general work of complete demolition, and that was of a house that had been whirled about end for end and left on its foundation as a wreck. Reaching the freight depot of the Manitoba R. R., the wind tore that to pieces, overturned the long lines of freight cars, carried the trucks away, and even in places wrenched the iron rails from the ties. In one instance the trucks were blown from underneath a car, dropping the latter on the track where it was left. By a merciful exemption, the hospital of St. Benedict was spared, although the houses in its vicinity were taken. The tornado left the city limits near the residence of Lieut. Gov. Gilman, tearing away his fences and killing his horses. The total loss of life in St. Cloud was 22 individuals, mostly woman and children, besides 40 or 50 more or less injured; and the total loss of property was $87,395, of which amount $50,000 fell to the share of the Manitoba R. R., while the remainder was divided among 64 sufferers and their families, thus rendered homeless. From these figures it will be seen that the dwellings were not of an expensive sort, and will readily be rebuilt by the generosity of contributors.

The tornado struck the Mississippi River at a point opposite the village of Sauk Rapids, and fishermen who were in full view of the crossing aver that for a few moments the bed of the river was swept dry; and in corroboration of this remarkable statement they showed me a wide marshy spot where no water had been before this event took place! Two spans were torn away from the substantial wagon bridge below the rapids, one span being hurled up stream and the other down it by the rotary motion of the blast; and great blocks of granite being also torn bodily out from the piers. The large flour mill near the bridge was leveled. The depot of the Northern Pacific R. R. was demolished, and the central portion of the village itself was then attacked with the greatest violence. Being the county seat, the court-house was located here, a substantial structure,

of which only the vault, six iron safes, and the calaboose were left—the latter turned upside down. A fine new schoolhouse, costing $15,000, was completely swept away. The Episcopal church was so utterly removed that the sole relic thus far found is a battered communion plate. The floor of the large skating rink is all that remains of that structure. Stores, hotels, a brewery, and four-fifths of the residences in the village were scattered as rubbish along the hillsides, or borne away for miles through the air. The caprice of the storm was shown here and there. The lower story of one house was removed to parts unknown, while the upper story was left on the foundation below. A large barn containing twenty mules was demolished, but the mules escaped without a scratch. A woman was lifted from her chair, carried over the walls of her roofless dwelling, and deposited in a thicket of scrub oaks several rods distant. A man told me that, after getting his family into the celler, he thought he would watch the storm for a moment; but being caught by it, he seized hold of the roots of a tree, and was flopped up and down, as a carpet that is being shaken, but escaped without serious injury. An iron safe was carried by the wind completely across the street, and left there as a monument of aerial energy!

The number of the killed at Sauk Rapids was 39, and about 100 were injured more or less. The fatal blows seemed to be of two kinds, either contusion about the head or stabbing by the lance-like splinters of boards whirled through the air. Many had their limbs broken by falling timbers and other heavy objects. Of sufferers still living, several are in a critical condition and may not survive. It is an instructive fact that, of those who had the presence of mind to take refuge in cellars, on hearing the roar of the approaching tornado, only one, so far as I could learn, fell a victim to its fury—a boy who was crushed by falling masonry in a part of the cellar farthest from the storm. I examined nearly every cellar in the village over which the storm had passed, and found that the portion *nearest* its direction of approach was free from rubbish, and would no doubt have proved to be a safe refuge.

An appraisement committee say that the total number of houses destroyed at Sauk Rapids, not including sheds and barns, was 109, and the total value of property destroyed was more than $290,000.

One of the saddest of the many tragedies marking this wide disaster took place at a farmhouse in the country, about sixteen miles north of Sauk Rapids, where a wedding party of thirty were assembled. The ceremony was just concluded, and the officiating clergyman was offering prayer, when the building was struck by the tornado. The bridegroom was killed outright, as were also fifteen others; seven more victims have since died, and only one of the company escaped severe injury of some kind.

Following the tornado's track through the forest, I was interested in observing that the scrub oaks had in so many instances resisted successfully the onslaught that had leveled larger and nobler trees. Their branches were grotesquely laden with torn garments, scraps of roofing, fragments of boards, articles of furniture, and other objects. This display was observable for miles. The depot sign "Sauk Rapids" was carried to a locality nine miles distant. A plank 14 inches wide and 12 feet long was transported 18 miles. A hunter 28 miles north of the village told me that he saw a black cloud approaching, from which he took refuge. But it did no further harm than to shower down bits of boards, lathing, torn books, etc. He picked up a ledger which was identified as belonging to the clerk of the county court.

I had excellent opportunity of noting, in a large open field, the proofs that the tornado traveled in a serpentine path, and with rapid rotation on its axis. Along the right hand of the general track, the boards and other fragments of houses, and the overturned trees, were all disposed so as to point forward and inward toward the line of march. Those along the left-hand side were invariably pointed backward and away from that line. Many large splinters were driven into the ground so firmly that, using all my strength, I could not pull them out again. A farmhouse standing near the left-hand margin of the track had its

right side intact, while on the left or outward side the windows were all broken in, and the walls and roof were pierced by numerous splinters. Estimates have been made as to the rate of the rotary motion that could drive timbers deep into the soil and that could send a splintered joist, like a huge javelin, completely through the roof of a dwelling, but I know of no satisfactory mode of calculation.

Putting together the testimony of various observers stationed at different points, the width of the tornado's track must have varied from 100 to 1,000 feet; its entire duration must have been rather less than one hour, lingering but a few moments in any one locality; and the entire distance traversed by it, from the starting point southeast of St. Cloud to the point where it burst in a heavy rainfall, considerably northeast of Rice's Station, was about thirty-five or forty miles. The total loss of life thus far reported from all points was about ninety individuals, and about twice that number injured. The sum total of property destroyed could not have been less than $400,000. H. C. HOVEY.—*Scientific American.*

THE VOLCANIC PHENOMENA IN NEW ZEALAND.

From Symons's Meteorological Magazine.

We have been favored with such full accounts of the great seismic disturbance which commenced about 2 A. M. on June 10th as to cause an *embarras de richesses.* One of our New Zealand correspondents, besides his own personal narrative, has sent us various numbers of the *Wellington Evening Post,* with colored lithograph views and maps of the district affected, and also the special edition of the *Auckland Evening Star,* with an eight page supplement crammed with lithographic reproductions of photographs, a map, and sketches of the disaster. Besides these there have been accounts (nearly all different) in most of the daily and weekly papers. We may, however, specially notice the *Illustrated London News* of August 7th, *Nature* of July 20th and August 5th, *Science* (New York) of July 23rd, and the *Pictorial World* of August 5th. Of course by far the easiest course would be to pick out a series of paragraphs from these

papers and re-print them, but that is not our notion of an editor's duty. What we have tried to do is to make ourselves acquainted with the various reports and statements, each of course reporting the facts merely as they appeared to one person from one place, and then to write the description in as near as we can chronological sequence, and as viewed from a safe height above the district, say four or five miles—below that, a blow from a piece of pumice might have been experienced.

LOCALITY.

Near the intersection of the line of longitude 176° E. of Greenwich with that of 38° latitude S. and about 20 miles inland from the shore of the Bay of Plenty on the N.E. coast of the N. Island of New Zealand lies a district long celebrated as one of the wonders of the world. This is near the centre of an area of about 30,000 square miles, extending North-eastward from a mountain called Ruapehu (9,850 feet high), past Tongariro (7,800 feet), Lake Taupo with an area of about 200 square miles and 1,175 feet above sea level, crossing the valley of the river Waikato, and then coming on the gem of the whole, the hot springs and lakes of Rotomahana, Tarawera, Roto Rua, and Roto Its, and the celebrated Pink and White Terraces.

PREVIOUS STATE.

We give first one of the best general accounts which we can find:

The physical formation of the whole region at once betokens its volcanic origin. In the centre was the beautiful lake Tarawera, whose winding shores were fringed by bold mountains with conical peaks, over which spread a rich growth of giant-like vegetation, while picturesque headlands, deep bays, broad valleys, and weird gorges came before the view at every turn. At the southern end of this lake, Mount Tarawera rose a thousand feet above the surrounding country in the form of a colossal cone. From time immemorial it has remained in a quiescent state, until suddenly, as if awakened into a new life, it has sent forth its showers of ashes and rivers of mudlike lava for a distance of sixty miles over the surrounding plains. Mount Tarawera was, before the eruption occurred, connected with Lake Rotomahana by a bold range of volcanic hills, from whose valleys and sides issued at all times vast volumes of steam and sulphurous vapors. The lake itself, about a mile in diameter,

with its hot green water, lay in the centre of towering mountains. Everywhere around one could see the wondrous workings of fire and water in the geysers, mudholes, and fumaroles that lined its shores. Every miniature island and jutting point had its cluster of boiling springs, every valley its waving cloud of steam, while the very waters of the lake sent up bubbles of heated gases from the depths below. In describing this curious lake, in his book on "The King Country," Mr. Kerry-Nicholls states: "We entered a rocky desolate gorge, seamed and fissured in every direction with streams of hot water, while jets of hissing steam bursting from its sides marked the site of subterranean fires. The heated quaking soil was covered with thick deposits of silica, sulphur, oxide of iron, pumice, obsidian, scoria, and other volcanic products, and with its sulphurous atmosphere, fierce heat, and shrieking sounds, it appeared as if we had entered by a short cut to Pandemonium. The high hills on each side of the gorge rose up in quaint fantastic shape, and their rugged sides, composed of shattered volcanic rock, sent forth water and jets of steam from a thousand fissures, while all the huge rocks, boulders and stones had been pitched and tossed about by the tremendous action of fire and water into a wild and endless confusion. One of the most remarkable wonders of this region was Te Ana Taipo, or the "Devil's Hole," a deep circular aperture in the rocky gorge, from which a column of transparent steam burst from a small aperture at the bottom of the deep funnel-shaped hole with a deafening screeching sound like the voices of a thousand fiends. Never was heard anything so wild and so dismal as the human-like wailings of Te Ana Taipo; and as the thrilling noise went echoing over the hills one expected to see an army of evil spirits spring up around, headed by his Satanic Majesty himself. We came suddenly upon Ngahapu, an intermittent boiling geyser, which burst forth with a loud noise from the farther side of an oval-shaped basin about a hundred feet in circumference, and in which the heated, steaming water, in a constant state of ebullition, kept rising and falling in great hot waves which lashed themselves into fury against the rugged sides of the cauldon with a loud hissing sound, as a column of boiling water shot high into the air. Right above this spring, on the side of a hill, a transparent jet of steam burst forth from a narrow fissure with a loud, screaming noise, as if anxious to escape from its rock-bound prison-house, and blow up the surrounding country. It blew, whistled, steamed, and hissed and shrieked away like a fifty horse-power engine, and the terrific pressure acting in some way upon the rocks below made them send forth a sound like the 'thud' of a great steam-hammer.

It was on the fiery borders of this remarkable lake, and the slopes of fern-clad hills that sloped gently down to its brink, that the marvellous Pink and White Terraces, now unfortunately destroyed by the force of the eruption, delighted the beholder, as he gazed in wonder on their

chaste and singular design. The same author thus writes of Te Tarate, or the White Terrace:—"As we look upwards the whole outline of the terrace assumed a semicircular form, which spread out at its base in a graceful curve as it sloped gently down to the margin of the lake. Then broad, flat, rounded steps rose tier above tier, white and smooth as Parian marble, and above them terrace after terrace mounted upward, rounded and semicircular in form. All were formed out of a delicate tracery of silica, which appeared like lacework congealed into alabaster of the purest hue. Each lamination or fold of this beautiful design, was clearly and marvellously defined, and as the glittering warm water came rippling over them in a continuous flow Te Tarata sparkled beneath the sun as if bedecked with diamonds and myriads of other precious gems. Crystal pools, shaped as if to resemble the form of shells and leaves, and filled to their brims with water, blue and shining as liquid turquois, charmed the eye as we mounted to every step, while around the edges the bright crystals of silica had formed encrustations which made them appear as if set in a margin of miniature pearls."

The crater of Te Tarata was formed of a milk-white circular basin of two hundred feet in diameter, filled to overflowing with brilliant transparent water. Here the hissing liquid in a constant state of ebullition bubbled and hissed in the form of a boiling fountain from which a waving cloud of steam floated constantly upward.

The Pink Terrace rose majestically from the shining green waters of the lake with rounded edges and waving curves, the buttress-like masses which supported the fringed edges of the terraces bent over and formed miniature grottoes, resplendent with festoons of pink-tinted silica and and rose-coloured stalactites, which appeared to have been woven together by nature and crystallised into their present shape,while innumerable pools or salmon-coloured basins, all exquisitely and quaintly formed with curling shell-shaped margins, were resplendent with water of the purest and darkest blue.

The steaming cauldron was formed by a round alabaster-like basin about a hundred feet in diameter. Here the deep dark blue water, within a few degrees of boiling point, lay without a ripple upon its surface, which shone with the brilliancy of transparent crystal, and beneath which the silicious deposits which encrusted the sides of the crater assumed all the marvellous and fantastic designs of a coral grove, tinted in glowing colours of yellow, blue, and pink.

We need not add much to the foregoing except a few measurements, which may give distinctness to the description, all distances being measured in straight lines.

Roto Iti, the most northerly lake, is about twice the breadth of Windermere and about its length, say two miles, from N. to

S. and nine from E. to W. and at an average distance of 15 miles N.N.W. of Tarawera.

Roto Rua, south-east of Roto Iti and almost adjoining it, is an approximately rectangular lake about five miles by four miles and 17 miles N.W. of Tarawera.

Roto Rua township, on the north shore of the lake is the principal place in the district, and just 15 miles N.W. of Tarawera.

Wairoa.—The Maori settlement is about eight miles S.E. of Rota Rua, seven miles W.N.W. of Tarawera, and on a stream joining a little lake (Roto Kakahi, about two miles by one mile) to the large lake Tarawera, so called after the mountain which rises to the east of it.

Tarawera lake is irregular in shape, but approximately square, and about 20 square miles in area. It was fed at the S.E. corner by two streams.

Roto Mahana, the most southerly lake which need be mentioned was a hot-water lake feeding Tarawera, and close to it were the Pink and White Terraces with which everyone who has seen them has been so charmed. These were about three miles S.W. of Tarawera.

We have, therefore, to picture to ourselves an area about equal to that of England from London to Hull and from Yarmouth to Hereford very thinly peopled, with many large lakes, many mountains of from 1,000 to 10,000 feet in height, all more or less volcanic in character, but nearly quiescent except an area of rather more than half the size of Leicestershire, where hot springs and lakes, geysers, and other phenomena gave constant proof of subterranean energy, yet as no violent eruption had occurred for many years none was expected.

THE OUTBURST.

About 1 A. M. on June 10th the earthquake rumblings with which the residents are familiar gave place to more serious ones, and at 2:10 A. M. there was one of terrific force, after which a rush of fire and dust proclaimed the opening of Mount Tarawera as an active volcano. "In about an hour craters opened in and around Lake Roto Mahana and vomited enormous quantities of

heavy mud, which with hardly conceivable rapidity spread disaster for miles around. Fifteen active fumaroles belching forth stones have been counted on the site of Roto Mohana, and one of the largest occupies the place where the Pink Terrace once was." The few buildings at Wairoa suffered severely, being crushed by the weight of mud thrown upon them.

The schoolmaster and children were killed, and at one of the hotels a visitor shared the same fate. It is not known how many Maoris were killed, but certainly upwards of 100.

Tauranaga, 40 miles distant, was placed in total darkness by the thickness of the cloud of dust and ash, though the blaze of the volcano was visible in the S.E.

It is not easy to distinguish between dust and mud, for great winds and rains were produced by the eruption, and after all mud may be but pumice dust mixed with water—but it is only at places near to Tarawera that this difficulty exists. Dust fell on vessels 130 miles away. At Tauranaga (40 miles) it was about $\frac{1}{4}$ in. deep; at Taheke (18 miles) 4 in.; at Te Ngae (15 miles) 9 in.; at Tikitapu (8 miles) 3 ft.; at Rotokakahi (6 miles) a 4 ft. fence was nearly buried.

The area covered with indisputable mud seems to be about 15 miles square = 225 square miles, and over about 36 square miles it seemed to have the enormous thickness of 20 to 30 ft. At Te Ariki it is said to be 20 ft., and near Okaro lake 25 to 30 ft. The telegraph line man at Rotorua reported the wires to be coated with mud to the thickness of candles, and that the mud on the tops and insulators of each pole averaged 50 lbs. in weight.

*The eruption was heard at Christchurch, 300 miles S.S.W. of Tarawera.

The dust column was seen even from the other side of the island—from New Plymouth, distant 150 miles, the height of the top being estimated at 22,000 feet, or $4\frac{1}{4}$ miles.

CUTTINGS.—We are indebted to the Hon. Minister of Mines for the following telegram, giving a complete analysis of the volcanic dust so

*We have a note that the explosion was heard at Sydney at 11:50 P. M., Sidney time, which would correspond to about 1:30 A. M. at Roto Rua. Sidney is, however, more than 1,000 miles distant.

plentifully distributed on the East Coast.—Silica, 62·2; alumina, 14·2; sesquioxide of iron, 6·2; lower oxide of iron, 2·3; oxide of maganese, trace; lime, 8·7; magnesia, 0·4; potash, 0·9; soda, 1·5; combined phosphoric acid, 0·04; combined sulphuric acid, 0·08; combined chlorine, 0·1; combined carbonic acid, 0·3; organic matter, 2·4; moisture, 0·4; total, 99·72. *Notes.* (1) Above 20 per cent. free angular quarts; (2) the phosphoric acid is low; (3) potash, fair proportion for soil; (4) lime, nearly insoluble, combined with silica; (5) no value as to dressing except to open heavy clay; (6) no permanent value as soil; (7) may from its state of fine division yield at first some benefit.—*Wellington Evening Post.*

"Latest accounts as to the New Zealand volcanic convulsions state that an area of 2,000 square miles is covered with three inches and more of dust. About 20 miles square is covered mostly to the depth of 3 feet and more. For 400 square miles at the outside the country is totally destroyed, and 1,600 square miles is much damaged, the result depending on the problem of the fertilizing qualities of the deposit."—*Melbourne Argus.*

We venture, in conclusion, to congratulate our New Zealand fellow-subjects on two things: (1) on the vigour and ability of their newspapers; (2) on having in their service so skilled a geologist as Dr. Hector, F.R.S., whose instant despatch to the locality was a credit to the Government and a benefit to science. We cannot beter conclude this note than by reproducing

DR. HECTOR'S EXPLANATION.

"The Tarawera mountain, which was formerly a volcano, had been for ages heavily capped with obsidian, forming, as it were, an enormous glass dome, hermetically sealing it. The pent forces have now blown this dome away. The tremendous explosion has shattered the tubes, or the piping of the pink and white terraces, which probably led thousands of feet into the superheated regions of the earth. This let down the whole of Lake Rotomahana, and generated an inconceivable body of steam, which simply blew the entire valley and the adjoining river into the air. What was formerly the lake is now occupied by numerous mud volcanoes, some of them 600 feet high and 300 feet across, belching forth mud and stones to a height of 100 feet or more. If this volcanic activity continues unabated, the district will, perhaps, afford in the future greater attractions to the tourist than even the vanished terraces, with all their matchless beauty."

LITERARY NOTES.

CIEL ET TERRE. *Revue Populaire d'Astronomie, de Meteorologie et de Physique du Globe. (November, 1885, to June, 1886.) Deuxième Série, 1 re Année.*

(38) **Les grands tunnels des Alps et la chaleur du sol,** (d'apres Gaea, 1885, No. 9), pp. 421–424. A serious and unexpected obstacle met with in the construction of the St. Gothard tunnel was the peculiar condition of the underground atmosphere. The temperature within the tunnel ranged from 32.°5 to 35° c., while the amount of moisture was from five to six times as great as that of the external air; a condition of things which was the cause of much sickness among the laborers, thereby involving a serious increase in the cost of construction. To consider the practicability of tunnelling Simplon and Mt. Blanc, the writer makes use of the empirical formulæ which Dr. Stapff deduced to represent the temperatures at various points in the St. Gothard and Mt. Cenis tunnels. The resulting temperatures come out so high that unless special machinery to produce a vigorous ventilation were to be employed it would be impossible to pierce these mountains.

(39) **Notes. Le Bruit de l'Aurore Boreale,** pp. 430–431. Among other questions contained in a circular, sent to observers living in localities where the occurrence of an aurora is a common event, Mr. S Tromholt asks whether the display is ever accompanied by any noise, and if so, what is the nature of the sound. Of the 132 answers received 92 are affirmative and 21 negative. The testimony as to the character of the sound is quite varied, as can be seen from the following. A sound like that produced by—the tearing of silk—a flame—humming bee—drapery agitated by violent wind—distant storm—sea waves—flying bird—electric spark.

(40) **Visibilité des objets éloignés,** p. 432. Ordinarily the best time for viewing distant terrestrial objects is just before sunrise, the atmosphere being usually calm and but little charged with moisture. Distant mountains can, at times, be seen from points 360 kilometers away.

(41) **F. F. L'agrandissment des astres a l'horizon,** pp. 433–436. The opinion is expressed that the true explanation of the apparent enlargement of objects, when near the horizon, has not yet been given. The author cites several observations of his own and calls for a satisfactory explanation of the same.

(42) **Le Puits Artesian de Pesth,** pp. 456. At Pesth an artesian well is being bored, the present depth being more than 950 metres, furnishing a daily flow of nearly 800 cubic metres of water at a temperature of 70 c. It is proposed to increase the depth until the water attains a temperature of 80°.

(43) **Notes**, pp. 455–456. A. L. gives a review of Prof. J. Hann's *Die Temperatur-verhältnisse der österreicheschen Alpenländer.* The table giving the altitude for each month, of the isotherm for 0° is especially interesting as can be seen from the following:

Date.	Altitude of the region having an observed temperature=0°	Date.	Altitude of the region having an observed temperature=0°.
Jan. 6..	280 m.	July....	3410 m.
Feb. 5..	540	Aug....	3550
March 7	1090	Sept....	3360
April 6.	1700	Oct. ...	2710
May 7..	2360	Nov....	1660
June 5..	2990	Dec	660

(44) **F. Folie, Quelques remarques sur les marées atmospheriques, a l'occasion des flux solsticial signalé par Baeyer**, pp. 457–461. This paper is an adverse criticism of General Baeyer's explanation as to the cause of the variation in the level of the Baltic sea for different seasons of the year. Bayer attributing the changes to tidal action of the sun.

(45) **E. L., Classification des cours d'eau au point de vue climatologique**, pp. 487–491. This paper is a review of that chapter in Woeikof's "Les Climates du Globe" which treats of the relation existing between the character of the rivers and lakes of a country and the law of rainfall. The rivers are considered under nine different types or classes according to the topographical and climatic condition of the country.

(46) **Note**, p. 504. M. Ebermeyer finds from analyses of the atmosphere the following proportionate amounts of carbonic acid.

In the Bavarian forests 0.0329.
In the Bavarian plateaus 0.0320.
In the Bavarian mountains 0.0316.

The author calls into question Schlessing's theory as to the action of the ocean waters in causing the observed difference between the composition of the atmosphere in the northern and southern hemisphere.

(47) **J. Liagre**, pp. 505–511. **Le flux solsticial de la Baltique**, pp. 505–511. This article is a reply to M. Folie's criticism of General Baeyer's views as to the cause of the variation in the level of the Baltic. The subject of atmospheric tides is also discussed.

(48) **Les observations phenologiques des plantes**, (D'apres le professeur Hoffmann dans Gaea, No. 7, 1885) pp. 511–516. The connection existing between the different stages of development in a plant and the climate of the region in which the plant is found is not only an important one from a biological side but also from a climatological point of

view. Professor Hoffmann has calculated the mean succession of phases from February to October, for a series of plants in the neighborhood of Hesse-Darmstadt. Suggestive remarks are also made as to the methods of continuing and enlarging the present scope of the work.

(49) **Notes**, pp. 525–528. *L'origine de l' électricité atmospherique et des orages.* An ascending mass of air set in motion by the sun carries with it the watery vapor which on reaching the upper regions does not immediately attain the temperature of the surrounding air containing frozen particles of water; it thus happens that two clouds, one composed of liquid and the other of frozen particles of water may be in contact with each other. Now Faraday long ago showed that water in the act of freezing to ice generated electricity. M. Sohncke found that it was possible to charge ice in this way with positive electricity from which he concludes that the electricity formed in the storm clouds is generated by the freezing of the watery particles to the minute ice crystals.

(50) **Influence de la pression atmospherique sur les degagements de grison dans les mines.** From observations made in the coal mines near Karwin, Austria, the following facts have been determined. (1) In general the amount of fire-damp in the air increases with a diminution in the atmospheric pressure, while the reverse is the case when the pressure increases. (2) The volume of fire-damp depends upon the rapidity of the barometric changes, and not upon the absolute pressure. (3) If the barometer after having risen rapidly continues to rise a little, or remains stationary for a time, the volume of this gas increases gradually, on the other hand if after a sudden descent the barometer continues to fall slowly a decrease in the amount of fire damp is noticed.

(51) **Le hauteur des nuages**, pp. 560–572. Four plates, illustrating the nimbus, cirrus, cumulus, stratus, cirro-cumulus and cirro-stratus forms of clouds accompany this paper; there is also a diagram, together with a description, of the instrument used by the Upsala observers, M. M. Ekholm and Hagström, for finding the heights of these clouds. According to their measurements the nimbus, cumulus and cumulo-stratus are, in general, at an altitude which is less than 4,000 metres, while the other forms of clouds are at a greater elevation. As to the thickness, they find that while the lower surface of the cumulus remains at nearly a constant altitude whatever the pressure may be, the upper surface and consequently the thickness is subject to great variations. As the pressure decreases the cumuli increase in thickness, reaching their greatest magnitude during a storm.

(52) **Revue climatologique mensuelle.** These reviews by A. Lancaster appear each month and form an important part of Ciel et Terre. The observations upon which the published data depend, are made at the Bruxelles Observatory, which has an altitude of 57 m. above sea level.

The mean, maximum and minimum readings of the barometers and thermometers, the humidity, mean daily evaporation, precipitation, dominant direction of the wind, etc., are some of the more important results which are tabulated. Descriptions of local storms and the more or less unusual phenomena are written in a style which is quite attractive.

(53) **Baromètres lumineux**, pp. 44–45. As early as 1676 Picard observed that in the dark his barometer emitted light, but the matter seems to have received but little attention, doubtless owing to the fact that the conditions necessary for producing this phenomenon were in nearly all cases wanting. In 1723 Du Fay found that in order to have certain results it was necessary to keep the tube perfectly dry, at least near the upper end of the mercurial column where the phenomenon is observed, and to use mercury from which the air and all impurities have been expelled. According to these directions all our first class barometers should be self-luminous when the tube is dry.

(54) **E. Lagrange.** *L'accroissement du nombre des coups de foudre en Europe et l'origine de l'électricité des orages*, pp. 108–114. The number of hypotheses that have been advanced to account for the marked increase of lightning in Europe is even greater than the number of theories to account for the origin of atmospheric electricity. According to Karsten the increased frequency of damage by lightning, in Germany, is to be attributed to the wholesale destruction of the forests; while according to others the ever increasing net-work of metallic conductors is believed to cause the observed effects. M. Andries calls attention to the great increase in the number of factories, with which the surface of Central Europe has been covered in the last ten years. The friction of the atmosphere with the dust and vapor given out by these factories, he thinks might account for the origin of the increased frequency of lightning. He also states that the more frequent occurrence of the aurora might be due to the same cause.

(55) **Les lueurs crepusculaires**, pp. 69–71. In this article the labors of Prof. Kiessling on the red sunset phenomena are briefly reviewed. The results of the personal observations of Dr. Hirn are also given; according to this observer the particles reflecting the light are at least 150 kilometers above the earth's surface. This great height would seem to indicate that the observations were made on what is known as the secondary glow, which, according to Ricco, is only a reflection from the first. It seems to be almost certain that the material which caused these phenomena came from the Krakatoa eruption.

(56) **La pole de froid asiatique**, p. 93. The parties sent out by the Russian government to explore the islands of New Siberia report that the mean temperature of January, 1885, was —52.°7 Cl, and the absolute minimum —68.°0 C.

(57) **E. Lagrange.** *La tremulation des étoiles*, pp. 145–150. The oscillatory motions of the stars when near the horizon seems to have been first described by Humboldt, who witnessed this singular phenomenon during his stay on Teneriffe. The explanation is doubtless to be looked for in great and sudden changes of temperature in the same region of the atmosphere. This motion is not to be confused with the phenomenon called "scintillation" which is a variation in the brightness and color of the star due to a partial decomposition of the light in passing through our atmosphere. An apparent oscillatory motion of objects in any part of the sky is also at times of a purely subjective character, being due to motion of the observer's eye. S.

(58) Washburn Observatory, Publications of, Vol. IV, Octavo, 221 and 25 pp., Madison, 1886. Besides an account of the astronomical work, this volume contains the summaries of meteorological observations for 1885, and also the general summary of observations at Madison, June, 1883. Professor Holden, the active and successful director, resigned his charge on January 1st, having been called to the more important post of director of Lick Observatory and President of California University. Mr. George W. Brown was the meteorological observer. H.

(59) **Reports, etc.**—*Alabama* Weather Service, octavo, monthly, published in the printing office of the A. & M. College, by special order of the Board of Trustees, Auburn, Prof. P. H. Mell, Jr., Director. April, May, June, also "Special Papers of the Alabama Weather Service" No. 2. *The Advantages of Deep and Thorough Preparation of the Soil*, Capt. W. H. Gardiner, octavo, 6 pages.—*Blue Hill Meteorological Observatory*, Blue Hill, Norfolk Co., Mass. A. Lawrence Rotch, Proprietor, H. Helm Clayton, Observer. Summary of observations for April, May, June, and July. Also summary of observations for the year ending January 31, 1886. Also Blue Hill Weather signals.—*Buffalo, N. Y. Office* of the Board of Health, statement of mortality, accompanied by daily Meteorological Observations. Albert H. Briggs, M. D., Register. Weekly, April 3 to July 31, 1886.—*Canada*, Monthly Weather Review of the Meteorological Service of the Dominion of Canada. Charles Carpmael, Superintendent, Toronto, March, April, Quarto, 10 pages, Diagrams of Winds.—*Colorado*, Bulletin of the Meteorological Association, Prof. F. H. Loud, Secretary, Colorado Springs, Folio, April. This is the first Bulletin of the Association. There are fourteen Stations reporting.—*Hong Kong.* Weather Reports of the Hong Kong Observatory, W. Doberck, Astronomer, December, January, Folio, 12 pages. Also Results of Magnetic Observations made 1841–'85 in Hong Kong, and Magnetic Observations made during 1885. Each 2 folio pages.—*Illinois.* Monthly Weather Review, containing summary of Meteorological Observations made to the Illinois Department of Agriculture, Charles F. Mills, Secretary, Springfield, April,

May, Octavo, 32 pages.—*Indiana*, Summary from Stations of the Weather Service of De Pauw University, Prof. W. H. Ragan, Director, Greencastle, April, May, single sheets.—*Iowa* Weather Service Bulletins, Dr. G. Hinrichs, Director, July, single sheet. Also report on the drouth in Iowa.—*Italy*. Societa Meteorologica Italiana, Bolletino decadico pubblicato per cura dell' Osservatrio Centrale del Real Collegio Carlo Alberto in Moncalieri, July, August, July, Quarto, 16 pages.—*McGill College* Observatory, Montreal, Canada, Prof. C. H. McLeod, Superintendent, abstract for April, single sheet.—*Mexico*. Resùmen general de las Observaciones Meteorolòǵicas del Año de 1883, City of Mexico, Don G. B. y Puga, single sheet with diagrams.—*Michigan*. Crop Reports, office of Secretary of State, May, June, July, Obtavo, 8 pages.—*Minnesota*, Weather Service, Prof. Wm. W. Payne, Director, Dr. R. McGinnis, U. S. Sig. Corps, in charge, April, May, June, July, Octavo, 4 pages, besides special bulletin.—*Missouri*, Weather Service, Maurice Johnson, Assistant in charge, Washington University, St. Louis, April, May, June, July, Octavo, 4 pages, with rainfall map.—*Nashville*, Weekly Rainfall Circulars issued by the Signal Service, L. N. Jesunofsky, Sergeant, single sheets.—*Nebraska* Weather Service Bulletin and Crop Report, Biswell Observatory, Doane College, Crete, Prof. G. D. Swezey, Director, April, May, June, single sheets.—*New England* Meteorological Society, W. M. Davis, Secretary, Cambridge, Mass. Bulletins for April, May, June, Octavo, 8 pages, with rainfall and temperature map.—*New York* Meteorological Observatory, Central Park, New York City, Daniel Draper, Ph. D., Director, May, June, Quarto, 4 pages.—*Oakland*, Cal., Report of Health Department, E. W. Buck, Health Officer, June, single sheet.—*Ohio* Meteorological Bureau, E. H. Marks, Secretary, Columbus. Reports for March, April, May, June, Octavo, 60 pages.—*Pacific Coast*. Rainfall Report compiled by Lieut. W. A. Glassford, Signal Corps, U. S. A., in charge Pacific Coast Division, published as a supplement of the *Daily Commercial-News* of San Francisco, July.—*Pilot Chart* of the North Atlantic Ocean, published monthly at the Hydrographic Office, Navy Department, Washington, D. C., Commander J. R. Bartlett, Hydrographer. Charts for April, May, June, July.—*Protem*, Taney Co., Missouri, MSS. Report, April, Silas C. Turnbo, Observer.—*Tennessee*, State Board of Health, J. B. Lindsley, Secretary, Nashville. Bulletins March, April, May, June, Octavo, 14-20 pages.—*United States* Signal Service, Monthly Weather Review, Gen. W. B. Hazen, Chief Signal Officer, Lieut. H. H. C. Dunwoody, Editor, March, April, May, Quarto, 28 pages, five charts.—*Wytheville*, Va., Howard Shriver, Observer, summaries of observations since 1860, four separate sheets.

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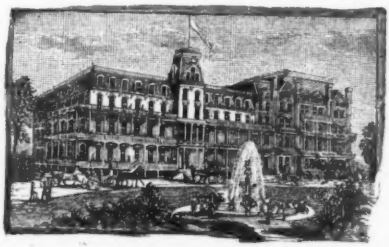

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